

Enthalpy: Review Questions – Answer Key

1. $Q_1 = mc\Delta T$
 $= (454) (0.227) (231.9 - 25)$
 $= + 21\,322.7 \text{ J}$

$Q_2 = (454) (59.2)$
 $= 26\,876.8$

$\Delta H = Q_1 + Q_2$
 $= + 48\,199.5 \text{ J}$
 $= + 48.2 \text{ kJ}$

2. $Q_1 = mc\Delta T$
 $= (1000) (2.44) (78.29 - 20)$
 $= 142\,227.6 \text{ J}$
 $= 142.2 \text{ kJ}$

$\text{C}_2\text{H}_5\text{OH} = 46\text{g/mol}$
 $\frac{46}{1 \text{ mol}} = \frac{1000\text{g}}{x \text{ mol}}$
 $= 21.739 \text{ mol}$

$Q_2 = (21.739) (38.56)$
 $= 838.3 \text{ kJ}$

$\Delta H = + 981 \text{ kJ}$

$$\begin{aligned}
 3. \quad \Delta H^\circ_{\text{(rxn)}} &= \Delta H^\circ_f (\text{P}) - \Delta H^\circ_f (\text{R}) \\
 &= [2(\text{CO}_{2(\text{g})}) + 4(\text{H}_2\text{O}_{(\text{l})})] - [5(\text{O}_{2(\text{g})}) + 2(\text{CH}_3\text{OH}_{(\text{g})})] \\
 &= [2(-393.5) + 4(185.8)] - [0 + 2(328.2)] \\
 &= -2586.6 \text{ kJ/2 mol of CH}_3\text{OH} \\
 &= -1293.3 \text{ kJ/mol}
 \end{aligned}$$

Or

$$\begin{aligned}
 n \text{ mols of CH}_3\text{OH} &= \frac{m}{Mr} \\
 &= \frac{0.115}{32}
 \end{aligned}$$

$$\frac{0.115}{1110} = \frac{32}{xJ}$$

$$? \times J = -328 \text{ kJ}$$

4. Exothermic

$$\begin{aligned}
 n(\text{NO}) &= \frac{1.25}{14.01 + 16} \\
 &= 0.04165 \text{ mols}
 \end{aligned}$$

$$0.04165 \div 2 = 0.02083$$

$$\begin{aligned}
 Q &= (\Delta H/\text{mol}) (n \text{ mol}) \\
 &= (-114.1) (0.02083) \\
 &= -2.38 \text{ kJ}
 \end{aligned}$$

5. Endothermic

$$n(\text{CaO}) = \frac{10}{40.08 + 16}$$

$$= 0.1783 \text{ mol}$$

$$Q = (464.8)(0.1783)$$

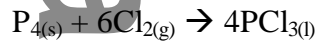
$$= + 82.9 \text{ kJ}$$

$$6. n(\text{P}_4) = \frac{3.56}{4 \times 30.97}$$

$$= 0.02874 \text{ mol}$$

$$Q = \frac{37.4}{0.02874}$$

$$= -1300 \text{ kJ/mol}$$



$$? H_{\text{rxn}}^{\circ} = 4(\text{PCl}_{3(l)}) - \text{P}_4 - 6(\text{Cl}_{2(g)})$$

$$= 4(-287) - 0 - 0$$

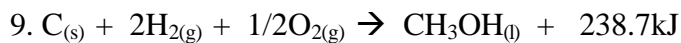
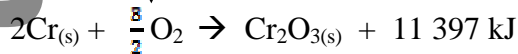
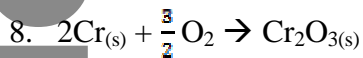
$$= -287 \text{ kJ/mol}$$

$$7. -6534.8 = [12(-393.5) + 6(-285.8)] - 2? H_f(\text{C}_6\text{H}_6)$$

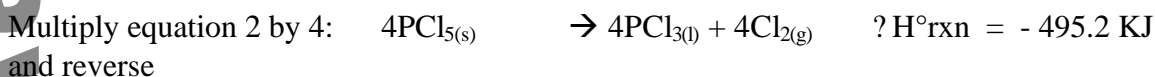
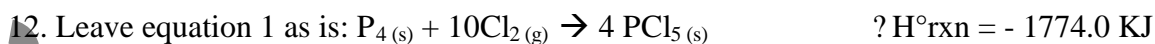
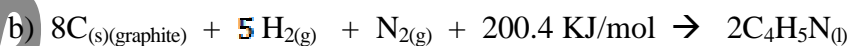
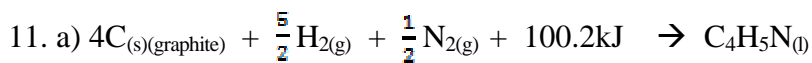
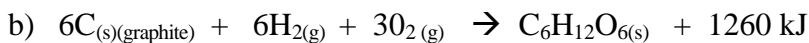
$$? H_f^{\circ}(\text{C}_6\text{H}_6) = \frac{12(-393.5) + 6(-285.8) + 6534.8}{2}$$

$$= \frac{98}{2}$$

$$= +49 \text{ kJ/mol}$$

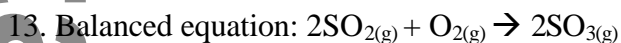


10. a) exothermic



$$?H^\circ_{\text{rxn}} = 1774.0 + 4(123.8)$$

$$= -1279 \text{ kJ}$$



$$?H^\circ_{(\text{rxn})} = ?H^\circ_f (\text{P}) - ?H^\circ_f (\text{R})$$

$$= (2(\text{SO}_{3(g)})) - (2(\text{SO}_{2(g)}) + (\text{O}_{2(g)}))$$

$$= 2(-395.7) - 2(-296.8)$$

$$= -197.8 \text{ kJ}, \therefore \text{Exothermic}$$

14. $?H^\circ_{(\text{rxn})} = ?H^\circ_f (\text{P}) - ?H^\circ_f (\text{R})$

$$= -395.7 - (-296.8)$$

$$= -98.9 \text{ kJ/mol}, \therefore \text{exothermic reaction}$$

$$?H^\circ_{(\text{rxn})} = ?H^\circ_f (\text{P}) - ?H^\circ_f (\text{R})$$

$$= -74.8 \text{ kJ mol}^{-1} - (-393.5 \text{ kJ mol}^{-1} + 2(-285.8 \text{ kJ mol}^{-1}))$$

$$= -74.8 \text{ kJ mol}^{-1} + 965.1 \text{ kJ mol}^{-1}$$

$$= 890 \text{ kJ mol}^{-1}, \therefore \text{endothermic reaction}$$

15. a)

$$\begin{aligned} ? H^{\circ}_{(rxn)} &= ? H^{\circ}_f (P) - ? H^{\circ}_f (R) \\ &= (-1206.9 \text{ kJ mol}^{-1} + (-241.8 \text{ kJ mol}^{-1})) - ((-982.5 \text{ kJ mol}^{-1}) + (-393.5 \text{ kJ mol}^{-1})) \\ &= -72.7 \text{ kJ mol}^{-1}, \therefore \text{exothermic} \end{aligned}$$

$$\text{b) } n_{\text{Ca(OH)}_2} = \frac{1000 \text{ g}}{74.093 \text{ g/mol}}$$

$$= 13.49655 \text{ mol}$$

$$\begin{aligned} \therefore Q &= (13.49655 \text{ mol})(-72.7 \text{ kJ mol}^{-1}) \\ &= -981 \text{ kJ} \end{aligned}$$

16. a)

$$\begin{aligned} ? H^{\circ}_{(rxn)} &= ? H^{\circ}_f (P) - ? H^{\circ}_f (R) \\ &= 0 + 3(-285.8 \text{ kJ mol}^{-1}) - (-842.9 \text{ kJ mol}^{-1}) \\ &= -857.4 \text{ kJ mol}^{-1} + 842.9 \text{ kJ mol}^{-1} \\ &= -14.5 \text{ kJ mol}^{-1} \end{aligned}$$

$$\text{b) } n_{\text{WO}_3} = \frac{1.00 \text{ g}}{231.84 \text{ g/mol}}$$

$$= 0.00431 \text{ mol}$$

$$\begin{aligned} ? H^{\circ}_{rxn} &= (0.00431 \text{ mol})(-14.5 \text{ kJ mol}^{-1}) \\ &= -0.06235 \text{ kJ} \\ &= -62.4 \text{ J} \therefore \text{exothermic} \end{aligned}$$

17. Given: $\Delta H_f^\circ(\text{Mg(OH)}_2(\text{s})) = -924.7 \text{ kJ/mol}$

$$\begin{aligned}\Delta H^\circ_{\text{(rxn)}} &= \Delta H_f^\circ(\text{P}) - \Delta H_f^\circ(\text{R}) \\ &= [\text{Mg(OH)}_2(\text{s}) + \text{H}_2(\text{g})] - [\text{Mg}(\text{s}) + 2\text{H}_2\text{O}(\text{l})] \\ &= [-924.7 + 0] - [0 + 2(-285.8)] \\ &= -353.1 \text{ kJ/mol or } -353 \text{ 100J/mol}\end{aligned}$$

$$Q = mc\Delta T$$

$$Q = (25)(4.18)(3)$$

$$Q = 313.5 \text{ J}$$

\therefore 313.5 J needs to be released

$$n = \frac{313.5}{353 \text{ 100}}$$

$$= 0.00088785 \text{ mol of Mg needed}$$

$$m = nMr$$

$$= (0.00088785)(24.31)$$

$$= 0.02158 \text{ g}$$

\therefore 0.0216 g of Mg needed.